ELEC 462/562: Optoelectronics

Instructor: Guru Naik, Assistant professor of Electrical & Computer Engineering
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Course Type: Lecture
Credits: 3
Course schedule: Tuesday and Thursday 4:00-5:15 pm in TBA
Office hours: Monday 3-5 pm + by appointment

Course Description:
Optoelectronic devices are ubiquitous in the forms of LEDs, lasers, displays and solar cells. Understanding the physics behind the operation of common optoelectronic devices is the aim of this course. This course provides an introduction to the fundamental principles of semiconductor optoelectronic devices. After reviewing the basic elements of quantum mechanics of electrons and photons, light-matter interaction (including laser oscillations), and semiconductor physics (band structure, heterostructures and alloys, optical processes), we will study the details of modern semiconductor devices for the generation, detection, and modulation of light.

Required Text:
E. Rosencher & B. Vinter, Optoelectronics (Cambridge)

Recommended References:
S. L. Chuang, Physics of Photonic Devices (Wiley)
C. Weisbuch & B. Vinter, Quantum Semiconductor Structures: Fundamentals and Applications (Academic Press)
J. H. Davies, The Physics of Low-Dimensional Semiconductors: Introduction (Cambridge)
J. Singh, Physics of Semiconductors and Their Heterostructures (McGraw Hill)
G. Bastard, Wave Mechanics Applied to Semiconductor Heterostructures (Wiley/Halsted Press)
A. Yariv, Quantum Electronics (Wiley)
A. E. Siegman, Lasers (University Science Books)
R. W. Boyd, Nonlinear Optics (Academic Press)

Objective:
The course aims at teaching the fundamental principles that govern the operation of semiconductor optoelectronic devices.

Student Learning Outcomes:
By the end of the course, the students should be able to:
Describe the three fundamental processes involved in light-matter interaction
Relate bandstructure of semiconductors with their photonic properties
Describe the operation of LEDs, lasers and photodiodes

Pre-requisites:
ELEC 262 OR PHYS 201 OR equivalent sophomore or higher level courses.

Topics:
1. Basic Elements of Quantum Mechanics and Light-Matter Interaction
   1.1. Time-independent Schrödinger equation
   1.2. Perturbation theory and transition probabilities
   1.3. Linear optical susceptibility
   1.4. Absorption, stimulated emission, and spontaneous emission
   1.5. Laser oscillations

2. Basics of Semiconductor Physics
   2.1. Band structure
   2.2. Electronic and optical properties of semiconductors
   2.3. Semiconductor heterostructures and quantum wells

3. Optoelectronic Devices
   3.1. Waveguides
   3.2. Photodetectors and solar cells
   3.3. Light emitting diodes
   3.4. Laser diodes

Homework:
A problem set will be assigned every other week.

Only for students registering at graduate level:
In addition to homework and exams, graduate students are required to make a 15 min conference style presentation near the end of the semester on recent topics in optoelectronics/photonics research.

Grading:
Your final grade will be determined based on the following weights:
Homework – 40%
Mid-term exam – 30%
Final exam (+ presentation for grad students only) – 30%
Late submission of homework assignments may attract penalty. Assignments received after solutions are posted will not be graded.

Honor Code Policy:
You may use your text, course notes, and any other reference materials. You may discuss problems, general strategies, with other people (in the course or not). However, you must turn in your own copy of the solutions. You should avoid using the completed work of other students, old homework solutions, and old exams and solutions. You should understand and be able to recreate any part of the solutions on your own.

Absence policy:

Class attendance is required during mid-term exam, quizzes and final presentation at the end of the semester. Students are not required to attend the lectures, but they will be responsible for the material covered during the missed lectures. The slides presented during the class will be available on the course website, and it is the responsibility of the student to make up for the missed lecture contents.

Students with Disabilities:
Any student with a documented disability seeking accommodations in this course should contact the instructor after class or during office hours. Additionally, please contact Disability Support Services in the Allen Center.

Updates to the Course:
Information contained in this course syllabus, other than the absence policies, may be subject to change with reasonable advance notice as appropriate.